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High and mighty: implicit associations between space and social status

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Figurative language and our perceptuo-motor experiences frequently associate social status with physical space. In three experiments we examine the source and extent of these associations by testing whether people implicitly associate abstract social status indicators with concrete representations of spatial topography (level versus mountainous land) and relatively abstract representations of cardinal direction (south and north). Experiment 1 demonstrates speeded performance during an implicit association test (Greenwald et al., 1998) when average social status is paired with level topography and high status with mountainous topography. Experiments 2 and 3 demonstrate a similar effect but with relatively abstract representations of cardinal direction (south and north), with speeded performance when average and powerful social status are paired with south and north coordinate space, respectively. Abstract concepts of social status are perceived and understood in an inherently spatial world, resulting in powerful associations between abstract social concepts and concrete and abstract notions of physical axes. These associations may prove influential in guiding daily judgments and actions.

Keywords: spatial cognition, social status, north–south bias, metaphor, embodiment, IAT

INTRODUCTION

For millennia, cultures have manipulated space at both small and large scales, from footwear to city planning, to convey social status (Hodder, 1987; Bourdieu, 1989; Margolies, 2003). The ancient Maya associated power and wealth with higher elevations and the north, and arranged their cities accordingly, placing leaders and elite atop hills, and to the north within civic centers (Ashmore, 1991; Robin, 2001). Today, the link between social status and the vertical dimension is deeply ingrained in our thought and environment, demonstrated by linguistic references to social *hierarchies*, with *high* status individuals acting as *over*seers, or metaphorically *climbing the corporate ladder*. Further evidence from the built environment reinforces this link through the elevated placement of high status real estate (e.g., CEO's offices) and prominent buildings (e.g., the U.S. Capitol on Capitol Hill). Our surrounding environment often functions as a non-linguistic symbol of abstract concepts like social status, and it is directly tied to perceptual and modality-specific experiences. Together figurative language, the built environment, and our perceptuo-motor experiences influence our mental representations by both explicitly and implicitly associating spatial information with intangible concepts. Consequently, abstract ideas such as social status may acquire spatial characteristics, and social information may be integrated into our conceptualization of space. As a result, the integration of spatial and social knowledge may bi-directionally influence real-world perception and decision making. The present three experiments extend recent research by examining the extent to which we associate social status with both concrete and abstracted representations of space.

Many abstract concepts can be understood through metaphorical connections to more experienced-based domains (e.g., Gibbs, 1994; Boroditsky and Prinz, 2008). In other words, our perceptual, sensory, and interoceptive experiences with the world can be used to structure our conceptualization of abstract concepts, and moreover, these perceptuo-motoric representations may even be necessary elements underlying conceptual understanding (Barsalou, 1999). According to theories of embodied cognition, thought is inherently bound to sensation and perception (e.g., Niedenthal et al., 2005), such that understanding both concrete and abstract concepts would require simulation of modality-specific actions or neurocognitive states (e.g., affect; Willems and Casasanto, 2011). Grounding abstract words and concepts in more concrete domains, such as space, allows us to transfer knowledge from our body–world (and brain–body) experiences to better understand otherwise intangible concepts. For instance, people use spatial representations when thinking about time, to the extent that an individual's perception of time is dependent upon their unique experiences with space (e.g., Boroditsky, 2000, 2001; Boroditsky and Ramscar, 2002). Further, abstract notions of positive versus negative affective valence are linked with both the horizontal (Casasanto and Chrysikou, 2011) and vertical (Meier and Robinson, 2004) spatial axes. More specifically, Casasanto's *body-specificity hypothesis* suggests that our bodily interactions with the environment give rise to mental metaphors grounding abstract concepts in a spatial dimension, such that unique experiences with the world (e.g., right versus left handedness) influence, at the very least, the origin of some abstract concepts (Casasanto, 2009).

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Similarly, abstract indicators of social status such as power, wealth, influence, or intellect are often associated with the vertical dimension through the use of metaphor in both linguistic (Boroditsky, 2000) and non-linguistic (Casasanto and Boroditsky, 2008) contexts, indicating that people may also structure their conceptualization of social status using their perceptuo-motor experiences with physical space. The idea that social status is conceptualized in the vertical spatial dimension is not new (e.g., Piaget, 1927/1969; Tversky et al., 1991). To date, dozens of experiments across a wide range of disciplines, from psychology to anthropology and archeology, have found relationships between the vertical spatial position "up" and power (e.g., Epperson, 2000; Robin, 2001; Schubert, 2005; Isbell and Silverman, 2006; Meier et al., 2007), and others have demonstrated that people mentally simulate upward motoric movement when thinking about wealth (Casasanto and Lozano, 2006). Notably, conceptualizing social status by grounding it in the sensory and motoric modalities may result in unfounded associations between "up" and power, indirectly influencing our judgments and decisions regarding other individuals. For example, meta-analyses have identified positive correlations between height and salary (1″ of height was worth an extra $789/year in salary; Judge and Cable, 2004), and individuals are more likely to hold a position of power if they are taller (Giessner and Schubert, 2007), suggesting that underlying associations between social status and vertical space may result in misperceptions of taller individuals as more powerful or influential, and consequently guide promotion decisions. Similarly, Carney et al. (2005) found that powerful individuals are perceived as having more erect posture, and other evidence suggests that executives can acquire status (and increase their own testosterone levels) by standing taller and taking up more space (Tiedens and Fragale, 2003). Together, this work demonstrates an underlying association between vertical space and social status that can bias perception and decision making.

Whereas much of the foregoing research may *prima facie* support an embodied representation of social status and other abstract concepts, evidence for a fully embodied account of abstract representation remains sparse and equivocal (e.g., Kranjec and Chatterjee, 2010; Dove, 2011; Pecher and Boot, 2011). Likewise, without directly testing for overlapping neural substrates responsible for concrete and abstract thought, and without demonstrating that brain regions tied to action simulation are required for comprehension, much of the extant literature does not necessarily provide unequivocal evidence for embodiment (e.g., Willems and Casasanto, 2011), and the results could instead be explained by a number of theories, including conceptual metaphor theory (e.g., Lakoff and Johnson, 1980), linguistic and situated simulation theory (LASS; Barsalou et al., 2008), the grounding by interaction framework (Mahon and Caramazza, 2008), and symbol interdependency theory (Louwerse and Connell, 2011). For instance, people might simulate modality-specific actions in the upward direction when they think about power, but the spatiomotor simulation might be epiphenomenal and unnecessary for comprehension. Instead, the concept of "power" could activate a semantic network of related, shallow linguistic concepts (e.g., power > king > mighty > high), triggering activation of the *amodal* concept "up," and only afterward simulation of an action. Some propose that abstract thought is partially represented in linguistic terms and partially in perceptuo-motoric systems, and while sensory simulation might not be necessary for comprehension, it may enrich conceptualization of abstract concepts (e.g., Mahon and Caramazza, 2008; Dove, 2009; for a review see Pecher et al., 2011). Regardless of the exact nature of abstract representations, a large body of data suggests that social status is thought about in spatial terms, likely resulting from experiences in a spatial world, thereby grounding an abstract concept in a relatively concrete domain.

The present experiments extend the current literature by investigating implicit associations between social status and real-world spatial concepts. Whereas previous research has identified the relationship between the vertical spatial position "up" and power (e.g., Schubert, 2005; Meier et al., 2007), we examine the extent to which this social–spatial association may apply to larger-scale concepts of vertical space encountered in the environment. Not only might we perceive taller individuals as more powerful, but we might also associate power with higher elevations (e.g., top floors of buildings or mountains), or even with more abstract representations of "up" (e.g., north). Recent evidence for a north-is-up heuristic (Brunyé et al., 2010) demonstrates physically unfounded associations between north and mountainous topography, and south and level topography. These associations are thought to be mediated by a vertically oriented conceptualization of mountains/level terrain and the north/south canonical axes. While people might not explicitly associate power with mountains or north (and most likely do not have a modality-specific experience associating power with mountains/north), if each of these different concepts shares an association with a more general spatial concept (e.g., "up"), then this general association might transitively link social status, topography, and cardinal direction. Such a link may occur either through second-order amodal semantic connections or simulation of modal-specific experiences shared between domains. If we do in fact transitively associate individuals' social status with concrete spatial features like topography and more abstract spatial features like cardinal directions, these associations could have pervasive influences on the way we perceive both individuals and space.

Testing this possibility, three experiments investigated the extent to which people automatically associate levels of social status (powerful versus average individuals) with different exemplars of vertical space, represented by spatial topography (Experiment 1) or cardinal direction (Experiments 2/3). To evaluate the strength of these associations, we adapted the implicit association test (IAT; Greenwald et al., 1998), a research tool that has traditionally been used to examine implicit associations in social and personality psychology. For example, the racial IAT evaluates the extent to which individuals automatically associate racial categories (i.e., black/white) with valence (i.e., good/bad). For the present experiments, we asked whether the categorization of average versus powerful individuals with topography (mountainous/level terrain; Experiment 1) or cardinal direction (north/south; Experiments 2/3) would reveal implicit associations between social status and different representations of vertical space. If the conceptualization of social status in the spatial domain extends beyond just vertical spatial positions (e.g., location on a computer monitor, vertical gestures) to larger-scale concrete (e.g., topography) and abstracted (e.g., cardinal directions) representations of space,

then the categorization of average versus powerful people should be facilitated when paired with a representation of level terrain/south and mountains/north, respectively. Faster pairings of average and level/south, and powerful and mountains/north (relative to the opposite pairings) would indicate an implicit and automatic association between hierarchical social status and real-world representations of vertical space.

EXPERIMENT 1

For our first experiment, we adapted the IAT to evaluate the implicit association between social status target categories (powerful/average individuals) and topographical attributes (mountainous/level terrain). If participants automatically conceptualize social status in the vertical dimension, and if this transitively links social status to other concepts associated with vertical space (e.g., topography), we could expect that they will be faster to categorize powerful individuals with mountains, which represent higher elevation, and average individuals with level terrain relative to when they categorize powerful individuals with level terrain and average individuals with mountains.

METHOD

Participants and design

Forty consenting undergraduates (age $M = 20.5$, SD = 1.74; 27 female) participated for monetary compensation ($10). In a within-participants design, each participant completed both congruent (powerful/mountainous, average/level) and incongruent (average/mountainous, powerful/level) associations.

Materials

The target social status and topographical attribute categories were represented with images (see examples in **Figure 1**). For the target categories, we developed a total of 16 images (302 × 330 pixels) depicting powerful and average individuals. To manipulate social status, we chose eight powerful individuals chosen from *Time* magazine's list of the world's most influential people (unfamiliar people only; wearing professional business attire), and eight average individuals from Google™Images (wearing casual attire). The individuals were equated for perceived age, gender, and skin tone across the average/powerful categories. Further, in a pilot experiment ($n = 10$) we collected ratings of nine traits – attractiveness, happiness, likeability, trustworthiness, understanding, intelligence, power, wealth, and influence – for each of the target image individuals, using 7-point scales. Ratings confirmed that average and powerful individuals were equated for attractiveness, happiness, likeability, trustworthiness, and understanding ($ps > 0.1$), and powerful individuals were judged as more powerful, wealthy, and influential than average individuals ($ps < 0.01$). Thus, any effects between average/powerful categories could be attributed to the greater perceived power, wealth, or influence of the powerful individuals, but are unlikely to be explained by manipulations of the other traits.

For the 12 attribute images (482 × 333 pixels), vertical space was depicted in 12 photographs, six of which depicted mountains and six depicted level ground, controlling for perceived climate (i.e., within each group of six images, three were from a cold/snowy and three from a warm/sunny climate). Luminance was equalized

FIGURE 1 | Example stimuli used in the adapted implicit association test. First row: Experiment 1 topography stimuli, with examples of mountainous (left) and level terrain (right). Second row: Experiment 2 cardinal indicator stimuli, with examples of north (left) and south (right) indication. Third row: Experiment 3 cardinal indicator stimuli, with examples of north (left) and south (right) indication. Fourth row: Experiments 1, 2, and 3 social status stimuli, with examples of powerful (left) and average (right).

across all target and attribute images. For stimulus presentation and data collection, we used an iMac with a 24″ widescreen display running SuperLab 4.0 (Cedrus, Inc.) software.

Procedure

Each participant completed seven blocks of categorization trials, in the standard IAT format developed by Greenwald et al. (1998),

categorizing both congruent and incongruent combinations in an order counterbalanced across participants. Images appeared on the screen one at a time, and social status and vertical space were categorized both separately and then in combination. All images appeared in both the congruent and incongruent conditions within subjects. Block 1 consisted of an initial target (i.e., social status) concept discrimination, during which the participant practiced categorizing the 16 powerful/average images using designated left (F) and right (J) keys over the course of 20 trials. For half of the participants, powerful was assigned to the left key and average was assigned to the right key; for the remaining participants, this mapping was reversed. Block 2 involved an initial attribute (i.e., topography) discrimination, during which the participant practiced categorizing the 12 mountainous versus level terrain images, over the course of 20 trials. Attribute categorization was always assigned to the same keys (mountainous terrain: F, level terrain: J). Block 3 involved 40 practice trials of the initial combined task, which required categorizing both the target and attribute images with the initially learned keys, such that half of the participants performed the congruent task (powerful/mountainous, average/level) first, and half performed the incongruent task (average/mountainous, powerful/level) first, thus minimizing potential combination order effects. Block 4 was identical to Block 3, but was considered an experimental block. During Block 5, participants completed 20 trials practicing a reversed target concept and key pairing from that learned in Block 1 (powerful/average images). Block 6 introduced the reversed combined task, and was identical to Block 3 except that the powerful/average were now associated with the opposite keys (F or J), requiring categorization of social status with different topography. Further, Block 7 was identical to Block 6, but, like Block 4, was considered an experimental block. The practice blocks (3 and 6) were designed to provide participants adequate time to practice the current category–key pairings, and to minimize effects of learning key combinations during the subsequent experimental blocks (4 and 8). Written instructions were provided preceding each of the seven blocks; in general, participants were instructed to classify each image as quickly and accurately as possible, but that it was alright if they made a few mistakes. Trials were randomized within each block and self-paced. Accuracy and response time data were automatically collected.

RESULTS

Scoring and analysis

We used an improved scoring algorithm to calculate corrected response latencies for test blocks, and also provide standardized IAT *D* values (Greenwald et al., 2003), both to ensure applicability to the extant IAT literature. The scoring algorithm removed trials with response latencies above 10,000 ms, and participants with latencies below 300 ms (no trials or participants met these criteria)[1]. Then, mean response latencies were calculated for accurate trials in the practice (3 and 6) and experimental (4 and 7) blocks. Response latencies for error trials were replaced with the mean for that block plus 600 ms, and the resulting trial response latencies were then averaged across blocks, providing us with a single corrected response latency mean for practice and experimental blocks for each of our two combined tasks (congruent, incongruent). The data was further separable as a function of whether the participant categorized congruent versus incongruent concepts during their first combined blocks.

For each experiment, we provide results from two separate analytical approaches. First, linear mixed-effects models with random intercepts for subjects and items were used to analyze corrected response latencies. Linear mixed-effects models allow us to take into account both fixed and random effects within the same model (e.g., Baayen et al., 2008; Louwerse and Jeuniaux, 2010). Models were fit using the *lme4* package (Bates et al., 2008) for the statistical program R. Response time outliers ($M \pm 2.5$ SD) were removed and remaining response times were $\log_{10}$ transformed to correct for positively skewed distributions. Data were then fitted to a model containing the fixed effects (i.e., Combination Type: congruent, incongruent and Combination Order: congruent first, congruent second) and random effects (i.e., subjects and items) using the restricted maximum likelihood estimation (REML) procedure. Standardized predictors for the fixed effects were used to reduce collinearity between our fixed-effects predictors. Further, since preliminary analyses indicated that random slopes for congruency were warranted for subjects, the following analyzes include random slopes along with random intercepts. Because MCMC sampling for models with random slopes has not yet been implemented for *lme4*, predictor significance is analyzed by comparing nested models based on differences between likelihood ratio chi-squares (χ^2) using the maximum likelihood estimation (ML). The results of chi-square analyses are provided for these model comparisons.

Our second and more traditional analytical approach examined the effects of Combination Type (congruent, incongruent) and Combination Order (congruent first, congruent second) in separate mixed ANOVAs by subjects and items.

In this experiment, outliers comprised 2.3% of all data, and pre- and post-transformed Fisher's skewness statistics were 1.14 and 0.54, respectively.

Implicit associations

A significant effect of Combination Type ($\beta = 0.042$; SE = 0.005; $t = 7.81$), revealed higher response latencies for incongruent relative to congruent trials, confirmed by model comparison [$\chi^2(1) = 38.37, p < 0.001$]. Further, there was no effect of Combination Order ($\beta = 0.002$; SE = 0.010; $t = 0.16$), and no interaction ($\beta = 0.001$; SE = 0.005; $t = 0.19$).

Similar results were found with the traditional ANOVAs, as described in **Table A1** in Appendix by subjects (F_1), and items (F_2).

Overall, conceptually congruent pairings (powerful/mountainous, average/level) were categorized significantly faster than incongruent pairings (average/mountainous, powerful/level), as depicted in **Figure 2**. The overall *D* value for the effect was 0.69.

DISCUSSION

The first experiment revealed faster categorization when powerful/mountains and average/level shared the same versus different

[1]Note that analyses using uncorrected response latencies revealed an identical pattern of results.

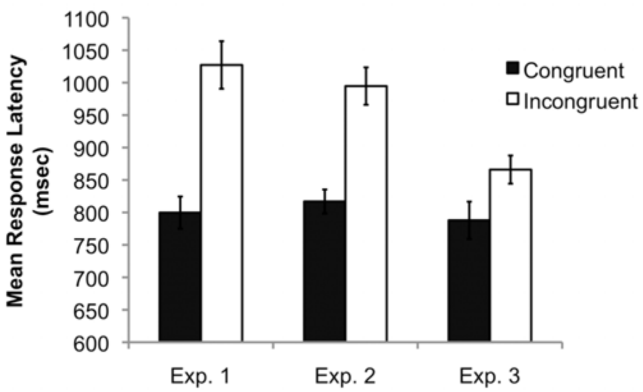

FIGURE 2 | Mean and SE response latencies for each of the two Combination Types (congruent, incongruent) and across all three experiments.

response buttons, confirming that there is an implicit association between social status and vertical topographic space. Thus, power is not merely associated with a vertically upward spatial position on a computer monitor or upward gesturing, but also larger-scale concepts of vertical space.

EXPERIMENT 2

Just how pervasive are the associations between social status and vertical spatial representations? To test the possibility that social status is implicitly associated with more abstract spatial representations (i.e., cardinal directions), we modified the IAT used in Experiment 1 by replacing the images of mountainous/level terrain with images using stars overlaid on a map to indicate north/south. If the association between power and "up" extends to a more abstract spatial domain, then we should see a response latency advantage when powerful/north and average/south are categorized together, relative to the opposite pairings.

METHOD

Participants and design

Forty undergraduates (age $M = 20$, SD $= 1.47$; 22 female) participated following the same design as Experiment 1.

Materials and procedure

All materials and procedures matched those of Experiments 1, with the exception of the attribute images (see examples in **Figure 1**). The topographical attribute images of mountains and level terrain were replaced with 12 map images (550 × 413 pixels) that represented cardinal direction. Each image depicted an urban satellite image background, gathered from unfamiliar locations (suburban Canada: Winnipeg, MB, Calgary, AB, and Toronto, ON), using the Google™Maps utility at a zoom level of $1'' = 500$ linear feet, and contained a single yellow (75 × 75 pixel) star occupying one of six locations along the northern or southern border of the image. Image luminance was equated using the same method as in Experiment 1.

RESULTS

Scoring and analysis

As in Experiment 1, preliminary analyses indicated that random slopes for congruency were warranted for subjects, so the mixed-effects analyses include random slopes along with random intercepts. As a result, predictor significance is again analyzed through model comparison.

In this experiment, outliers comprised 2.7% of all data, and pre- and post-transformed Fisher's skewness statistics were 1.09 and 0.54, respectively.

Implicit associations

A significant effect of Combination Type ($\beta = 0.025$; SE $= 0.005$; $t = 4.77$) indicated higher response latencies for incongruent relative to congruent trials, confirmed by model comparison [$\chi^2(1) = 18.85$, $p < 0.001$]. Once again, there was no effect of Combination Order ($\beta = -0.002$; SE $= 0.009$; $t = 0.29$), and no interaction ($\beta = 0.010$; SE $= 0.005$; $t = 1.82$).

Similar results were found with the traditional ANOVAs, as described in **Table A1** in Appendix by subjects (F_1), and items (F_2).

Overall, conceptually congruent pairings (powerful/north, average/south) were categorized significantly faster than incongruent pairings (average/north, powerful/south), as depicted in **Figure 2**. Overall D value for the effect was 0.35.

DISCUSSION

The goal of Experiment 2 was to examine the extent to which social status is associated with various representations of space. The results indicate that social status can be conceptually structured using more abstract representations of space, specifically north and south cardinal directions. However, one limitation of the present experiment is that rather than showing an implicit association between social status and *cardinal directions*, we might instead be showing an association between social status and vertically directed *visual attention*. Our stimuli used the placement of stars to represent "north" and "south," which would direct attention upward (north) or downward (south). While participants were categorizing these images under the labels "north" and "south," there remains the possibility that vertically oriented visual attention is driving our congruency effects, rather than an unequivocal association between cardinal directions and social status. On the other hand, a recent study (Santana and de Vega, 2011) found that briefly directed visual motion alone (i.e., separate from hand motion) did *not* produce semantic-visual direction compatibility effects on response times during a go/no-go task, suggesting that visual motion is less important than motor motion for comprehending words semantically linked with vertical space. Thus, we would not expect the slight shifts in visual attention imposed by the cardinal direction stimuli used in Experiment 2 to drive congruent/incongruent categorization effects to the extent observed.

EXPERIMENT 3

The third experiment controls for shifts in upward/downward visual attention that might be prompted by the star stimuli, and thus assesses a relatively direct association between social status

and cardinal direction. We replaced the cardinal direction indicators used in Experiment 2 (i.e., maps with stars) with images of compass roses to convey north/south. Thus, if the congruency effects demonstrated in Experiment 2 are at least partially due to an inherent association between cardinal directions and social status, then we should replicate the same pattern of results. In contrast, if social status is associated with upward and downward shifts in visual attention, and not cardinal direction, then there should be no speed advantage when categorizing powerful/north and average/south.

METHOD

Participants and design

Forty undergraduates age $M = 20$, SD $= 1.37$; 18 female) participated following the same design as Experiments 1 and 2.

Materials and procedure

All materials and procedures matched those of Experiments 2, with the exception of the attribute images (see examples in **Figure 1**). The cardinal direction attribute images of maps and stars were replaced with 12 images (550×413 pixels) that depicted a compass rose with either an N or S in the center. These stimuli were developed using six differently styled grayscale compass roses; half of these 12 images depicted the letter N in the center (north), and half the letter S in the center (south). The letters N and S were always depicted in red 60-point Times New Roman font. Image luminance was equated using the same method as in Experiments 1 and 2.

RESULTS

Scoring and analysis

As in Experiments 1 and 2, preliminary analyses indicated that random slopes for congruency were warranted for subjects, so the following analyzes include random slopes along with random intercepts, and predictor significance is analyzed through model comparison.

In this experiment, outliers comprised 3.0% of all data, and pre- and post-transformed Fisher's skewness statistics were 1.25 and 0.68, respectively.

Implicit associations

A significant effect of Combination Type ($\beta = 0.012$; SE $= 0.006$; $t = 2.19$) demonstrated higher response latencies for incongruent relative to congruent trials, and again confirmed by model comparison [$\chi^2(1) = 4.71$, $p = 0.03$]. Further, there was no effect of Combination Order ($\beta = 0.010$; SE $= 0.009$; $t = 1.13$), and no interaction ($\beta = 0.007$; SE $= 0.006$; $t = 1.31$).

Similar results were found with the traditional ANOVAs, as described in **Table A1** in Appendix by subjects (F_1), and items (F_2).

Once again, conceptually congruent pairings (powerful/north, average/south) were categorized significantly faster than incongruent pairings (average/north, powerful/south), as depicted in **Figure 2**. Overall D value for the effect was 0.35.

DISCUSSION

Results of Experiment 3 suggest that social status is associated with vertically conceptualized cardinal directions even when visual attention is consistently directed to the center of the screen. By depicting canonical terms using compass roses with either an N or S in the center, we replicated the implicit association between social status and north/south observed in Experiment 2, confirming that social status is associated with cardinal direction in the absence of explicit upward and downward shifts in visual attention. In addition, while Experiments 2 and 3 produced equivalent overall effects, the main effect of Combination Type was of slightly less magnitude in Experiment 3. Thus, there is some suggestion that the relatively robust effect of Combination Type in Experiment 2 might be at least partially due to stimulus-driven subtle shifts in visual attention along the vertical axis. In any event, it is compelling that the effect of Combination Type persisted with stimuli that would be expected to promote a relatively constrained central visual focus.

GENERAL DISCUSSION

In March 2011, the cover of *Harvard Business Review* displayed a compass pointing north, and the title, "How to Make It to the Top." The article outlines important leadership skills for "moving up" in the business world. We provide novel evidence that such marketing-based illustrations aimed at enticing a readership may accurately demonstrate how people perceive and think about social status and real-world spatial concepts. In Experiment 1, we demonstrated that social status is associated with topography, in that participants categorized powerful and average individuals faster when they were paired with mountainous and level terrain, respectively. Experiments 2 and 3 revealed an association between social status and north/south cardinal direction. Together, our results suggest that people not only automatically stratify levels of social power on a vertical axis, but also that mental representations of social status are linked with larger-scale and abstract spatial concepts also conceptualized in vertical space. Thus, above demonstrating a metaphorical mapping between abstract and concrete concepts, we have found evidence for second-order metaphorical mapping between abstract concepts, facilitated by shared associations with vertical space.

There is no evident reason why people would associate powerful individuals with mountains rather than plains or with the north rather than south. We do not often see or talk about CEOs standing on mountain peaks or occupying offices primarily on the north side of town. Yet, by merely thinking about social status as a hierarchy occupying the vertical spatial dimension, the present experiments suggest that we automatically extend social ideas not just to simple vertical spatial positions, but also to unrelated real-world spatial concepts that are likewise conceptualized in vertical space. From the perspective of Barsalou (1999) perceptual symbol systems theory, when we conceptualize north, mountains, or powerful people we might simulate similar modal representations of "up": perhaps looking upward at a parent, towering mountain peaks, or north on a map. Accordingly, if our modal representations of power and mountains/north both correspond with "up," then our conceptualizations of power and mountains/north would be more similar than those of power and level/south. Thus, concepts that share similar spatial associations (through either modality-specific or amodal representations of space) may transitively become associated.

Note that our results do not provide explicit evidence in favor of embodiment over metaphor theories (e.g., Lakoff and Johnson, 1980), and the observed associations between social status and topography/cardinal directions could be generated via an *amodal* second-order metaphorical mapping from target to attribute (e.g., *powerful* = *up*, *north* = *up*, thus *powerful* = *north*), driven by linguistic terms or other amodal representations, and removed from bodily experiences. It remains open whether action simulation and/or bodily experience are necessary to understand even inherently spatial concepts like up/down, forward/backward, left/right, irrespective of the abstract concepts themselves. Further, even if social status is understood through embodied representations, other abstract concepts (e.g., *democracy*) are likely not associated with specific perceptuo-motor experiences, and thus might be understood in other ways (Machery, 2007; Dove, 2009). For instance, some abstract concepts (e.g., *trust*) might be tied to interoceptive, affective experiences rather than an action, *per se*. Likewise, perhaps only abstract concepts tied to probabilistically consistent locations in space (e.g., *power* = *up*) remain directly associated with that location and corresponding action simulations, whereas concepts that are not bound to a particular location or salient experience (e.g., *implication*) might not depend upon a specific simulated perceptuo-motoric representation.

Moreover, Mahon and Caramazza's (2008) *grounding by interaction* framework suggests that the vertical sensory–motor action simulated when understanding social status may serve to enrich amodal information, "providing it with a relational context" (p. 10). Thus, while social status itself may be comprehended to some degree in amodal terms without activating a motoric simulation, a simulation grounded in perceptuo-motor experience may be necessary to bridge the connection between power, "up," and other experientially unrelated spatial concepts, like topography or cardinal directions. Similarly, the language and situated simulation (LASS) theory assumes that concepts are represented through the interaction of both linguistic and sensory–motor simulations, and deeper conceptual processing depends upon activation of the simulation system (e.g., Barsalou et al., 2008). The Symbol Interdependency Theory proposed by Louwerse and Jeuniaux (2008, 2010) also maintains that conceptual processing is both linguistic and embodied, depending on both the task and the stimuli (e.g., pictures, words). According to this theory, shallow, rapid mental representations often draw on linguistic factors, whereas deeper, slower representations are commonly tied to embodiment (Louwerse and Connell, 2011). Notably, language can reflect perceptual relations through linguistic structure, and thus these amodal linguistic factors may contribute to some putatively embodied effects. For instance, word pairs like "*monitor – keyboard*" and "*pan – stove*" appear more frequently in an order which preserves the physical relation of the objects, i.e., "*up – down*." With regard to the present experiments it is possible that the concepts "*powerful – average*," "*mountainous terrain – level terrain*" and "*north – south*" occur more frequently in language in the given order, and as a result the current findings may be mediated by linguistic structure. So while the words "*powerful*" and "*mountain*" may not often co-occur in language, their relative relationship within a common word binomial may contribute to associations between concepts.

Yet it is unclear if shallow linguistic processing alone is sufficient to enable such associations between otherwise unrelated concepts, and further, to what extent these basic linguistic structures are dependant upon perceptual relations. There remains the possibility that linguistic structure mediates associations between words *within* a binomial, but deeper, embodied processing may be necessary to draw associations *between* binomials. Further, because we used photographs as stimuli, it is likely that deeper processing via embodied factors contributed to conceptualization of the basic terms (e.g., *power*), and thus mediated the connection between the broader concepts (e.g. *power* > *mountain*). Experiments examining the representational nature of second-order associations between concrete and abstract concepts, represented with both pictures and words, may help inform the embodiment debate, and thus prove valuable for future research. In any case, the present experiments provide compelling evidence that social status is linked to abstracted spatial concepts like topography and cardinal direction via shared spatial associations in the vertical dimension. Whether similar linguistic structures reflecting these spatial relations are sufficient for bridging associations between seemingly unrelated word pairings remains open.

As with all cognitive tasks, the IAT carries a set of limitations. First, some suggest that the order of congruent/incongruent blocks might generate response slowing when participants switch categorization rules simply due to a task set switch cost (Messner and Vosgerau, 2010). In the present experiments, we accounted for block order effects by counterbalancing the order of congruent and incongruent blocks across participants. Thus, while the categorization response times for a single participant may not reliably indicate their personal associations between social status and topography/cardinal direction, the group level results are indicative of general associations. Second, others suggest that stimulus unfamiliarity might lead participants to more easily classify unfamiliar stimuli as unpleasant (e.g., low familiarity with African–American names can result in misleading associations between "black" and "unpleasant"; Ottaway et al., 2001; see also Brendel et al., 2001). However, because our attribute categories were not defined by valenced attitudinal beliefs (e.g., pleasant versus unpleasant), it seems unlikely that familiarity with target category stimuli would alter speeded categorizations. Third, IAT results may also be partially driven by asymmetric category salience, which may facilitate speeded classifications between target and attribute categories with shared salience (Rothermund and Wentura, 2004). Thus, if powerful individuals and mountainous terrain are perceived as more salient than average individuals and level terrain, participants might associate powerful/mountains because both categories are relatively salient when compared to average/level, and as a result, Experiment 1 effects might be partially attributable to salience asymmetry. It is unlikely, however, that this potential limitation influences Experiment 2 and 3 results, given no *a priori* justification for differential salience between north and south concepts. Finally, we also note that the IAT does not allow us to precisely identify the source or directionality of observed associations between social status and topography/cardinal direction. Indeed difficulty associating one of the pairings (e.g., powerful/level) could drive slower categorization response times for all incompatible trials, and consequently we cannot identify if

our effects are driven solely by associations between powerful and mountains/north, average and level/south, or both. Similarly, the IAT cannot provide insights into the directionality of associations between target and attribute categories; thus, participants may have stronger associations between powerful people and mountains/north, than mountains/north and powerful people, or vice-versa. In any case, the extant literature provides strong justification for the associative link between social status and the vertical dimension. It is thus likely that participants are mapping social status, topography, and cardinal directions to the vertical dimension relative to the other categories, associating powerful people/mountains/north as relatively more "upward" in comparison to average people/level/south. Future research may better disentangle the precise relationships between these factors.

Anthropological and psychological theories posit that associations between abstract concepts and physical percepts develop in response to everyday experiences (e.g., Hebb, 1949; Bourdieu, 1977; Barsalou, 1999). Since abstract concepts like social status are perceived in a spatial world (e.g., a small child perceives a taller parent as the leader), our mental representations of abstract concepts integrate spatial knowledge, most likely related on some level to perceptuo-motor experiences. In fact, preverbal infants as young as 10 months old automatically combine spatial and social concepts, using relative size as an indicator of social dominance (Thomsen et al., 2011), likely relying on accumulated experiences with their environment. Further, when we think about abstract concepts, drawing on these perceptuo-motoric experiences via simulation may serve to enrich our abstract representations, and enable us to draw connections between experientially unrelated concepts. Perhaps influenced by social–spatial experiences and their corresponding associations, our built environment also both reflects and conveys social concepts (e.g., kings on elevated thrones; sports victors on platforms; CEOs in top-floor offices), which then serves as yet another source of perceptual social–spatial associations. Cultures around the world have combined social concepts and vertical space for centuries. The ancient Maya constructed their cities with the elite in the north and atop hills (Robin, 2001). In Pohnpei, Micronesia, the most powerful chiefs sit in the highest places, and members of the highest chief's clan are called *sohpeidi*, literally meaning "facing downward" (Keating, 1995). The United States Capitol building was intentionally placed atop Jenkin's Hill, described by the original architect Pierre Charles L'Enfant as a "pedestal waiting for a monument. . .[whose]. . .height every grand building would rear with a majestied aspect over the Country all around" (L'Enfant, 1899, p. 35/29). The Capitol sits 80 feet above the Potomac, with commanding views up and down the river – a non-linguistic "symbol of federal power surveying the land over which the Legislature and Executive govern" (Worthington, 2005, p. 9). Likewise, underlying associations between power and "up" permeate our world today, impacting how we construct, arrange, talk about, and perceive the surrounding environment.

The implicit associations between social status and spatial concepts can impact both social and spatial perceptions, and thereby influence decision making across both domains. For instance, the association between cardinal direction and social status might lead us to pay more for a home on the north side of town. Similarly, we might head uphill (or up an elevator) to find leaders, or offer job opportunities or promotions to taller employees. Overall, these simple underlying associations wield a powerful, pervasive influence over how we understand the world, and may prove influential in guiding our daily judgments and actions.

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APPENDIX

Table A1 | ANOVA by subjects and by items results for each of the three experiments.

Experiment and effect	Subjects analysis result	Items analysis result
EXPERIMENT 1		
Combination type	$F_1(1,38) = 67.14$, $p < 0.01$, $\eta^2 = 0.64$	$F_2(1,15) = 98.34$, $p < 0.01$, $\eta^2 = 0.64$
Combination order	$F_1(1,38) = 0.12$, $p = 0.75$, $\eta^2 < 0.01$	$F_2(1,15) = 0.61$, $p = 0.45$, $\eta^2 < 0.01$
Combination type × combination order	$F_1(1,38) = 0.06$, $p = 0.80$, $\eta^2 < 0.01$	$F_2(1,15) = 0.44$, $p = 0.52$, $\eta^2 < 0.01$
EXPERIMENT 2		
Combination type	$F_1(1,38) = 37.82$, $p < 0.01$, $\eta^2 = 0.48$	$F_2(1,15) = 42.85$, $p < 0.01$, $\eta^2 = 0.41$
Combination order	$F_1(1,38) = 0.01$, $p = 0.94$, $\eta^2 < 0.01$	$F_2(1,15) < 0.01$, $p = 0.95$, $\eta^2 < 0.01$
Combination type × combination order	$F_1(1,38) = 2.43$, $p = 0.13$, $\eta^2 = 0.03$	$F_2(1,15) = 9.21$, $p < 0.05$, $\eta^2 = 0.07$
EXPERIMENT 3		
Combination type	$F_1(1,38) = 10.42$, $p < 0.01$, $\eta^2 = 0.21$	$F_2(1,15) = 10.72$, $p < 0.01$, $\eta^2 = 0.16$
Combination order	$F_1(1,38) = 0.58$, $p = 0.45$, $\eta^2 = 0.02$	$F_2(1,15) = 5.12$, $p < 0.05$, $\eta^2 = 0.06$
Combination type × combination order	$F_1(1,38) = 0.55$, $p = 0.46$, $\eta^2 = 0.01$	$F_2(1,15) = 0.43$, $p = 0.52$, $\eta^2 = 0.01$